EFFECT OF CIRCULAR HOLLOW SECTION ON THE STRENGTH OF FOAMED CONCRETE BEAM WITH PROCESSED SPENT BLEACHING EARTH AS PARTIAL REPLACEMENT OF CEMENT

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Beam adalah anggota struktur yang terdiri daripada keluli, konkrit, kayu dan bahan komposit yang melintang mendatar antara pendukung. Secara umumnya, rasuk konkrit bertetulang adalah pilihan pilihan sebagai unsur struktur di kawasan pembinaan. Walau bagaimanapun, berat diri konkrit pancaran bertetulang telah memberi kesan yang ketara kepada jumlah beban mati jika struktur dan tegasan dikenakan dipindahkan ke asas. Masalah berat telah diatasi dengan menggunakan konkrit berbuih (FC) kerana ia mempunyai kepadatan yang lebih rendah daripada konkrit biasa. Pemprosesan Spent Diproses (PSBE) adalah SBE yang telah dirawat dan boleh digunakan sebagai pengganti sebahagian untuk simen dalam konkrit berbuih akibat kesan pozzolanicnya. Objektif kajian ini adalah untuk menentukan beban maksimum lenturan lentur dengan menggunakan lenturan ujian empat titik (mengikut ASTM D6272), pesongan rasuk, dan mod kegagalan rasuk lenturan. Ketumpatan konkrit berbuih yang direka ialah 1600 kg / m3. 30% daripada PSBE yang dimasukkan adalah penggantian simen. Terdapat empat jenis rasuk yang disediakan termasuk rasuk FC dikawal sebagai rasuk padu tanpa bahagian berongga (Rasuk 1), rasuk berongga dengan pembukaan pekeliling diameter 20mm (Rasuk 2), rasuk berongga dengan Pembukaan pekeliling diameter 50mm (Beam 3), dan rasuk berongga dengan pembukaan pekeliling diameter 60mm (Beam 4). Dimensi semua rasuk adalah sama iaitu (150mm x 200mm x 1500mm) dan setiap rasuk disediakan untuk 3 unit untuk ujian. 4 Transduser Pemindahan Variasi Lineari diperuntukkan semasa 4 titik ujian lenturan dan pesongan direkodkan dan dianalisis. Rasuk berwarna putih dicat agar corak retakan visi. Corak retak dicatatkan apabila beban digunakan sehingga kegagalan rasuk. Kekuatan lenturan Beam 1, 2, 3 dan 4 masing-masing adalah 0.902 N / mm^2, 0.754 N / mm^2, 0.664 N / mm^2 dan 0.576 N / mm^2. Rasuk yang mengalami retakan menegak juga dikenali sebagai retak utama kerana tidak ada tetulang dalam rasuk. Untuk meningkatkan kekuatan lenturan dan pesongan rasuk, tetulang perlu dilaksanakan. Kawalan kualiti buih mesti dipantau untuk mendapatkan ketumpatan yang dikehendaki dan kekuatan konkrit. Oleh itu, kekuatan lenturan dan pesongan bahagian berongga bulat berkurangan kerana saiz rongga meningkat. Oleh itu, pesongan balang berongga menurun dengan peningkatan saiz pembukaan. Semua balang telah mengalami retakan tegak kerana tidak ada tetulang.

ABSTRACT

Beam is a structural member made up of steel, concrete, wood and composite material which span horizontally between supports. Generally, the reinforced concrete beam is the preferred choice as structure element in the construction areas. However, the self-weight of reinforced concrete beam had significantly affected the total dead loads if the structures and applied stresses transferred to the foundation. The weight problem has been overcome by using foamed concrete (FC) because it has lower density than normal concrete. Processed Spent Bleaching Earth (PSBE) is the SBE that has been treated and can be used as a partial replacement for cement in the foamed concrete due to its pozzolanic effect. Objective of this study is to determine the maximum load of flexural beam by using four point bending test (according to the ASTM D6272), the deflection of beam, and the mode of failure of the flexural beam. The density of designed foamed concrete was 1600 kg/m3. 30% of PSBE inserted are the replacement of cement There are four types of beam were prepared include controlled FC beams as solid beam without hollow section (Beam 1), hollow beam with the 20mm diameter circular opening (Beam 2), hollow beam with the 50mm diameter circular opening (Beam 3), and hollow beam with the 60mm diameter circular opening (Beam 4). The dimensions of all beams are same which are (150mm x 200mm x 1500mm) and each beam prepared for 3 units for testing. 4 Linear Variable Displacement Transducer are allocated during the 4 point bending test and the deflection are recorded and analysed. The beams were white painted in order to vision cracking pattern. The cracking pattern are recorded when load applied until the beams failure. The flexural strength of the Beam 1, 2, 3 and 4 was 0.902 N/mm^2, 0.754 N/mm^2, 0.664 N/mm^2, and 0.576 N/mm^2 respectively. The beams experienced vertical crack also known as ultimate crack because there is no reinforcement in the beams. In order to increase the flexural strength and deflection of beam, the reinforcement should be implemented. The quality control of foam must be monitored in order to get the desired density and concrete strength. Hence, the flexural strength and deflection of circular hollow section decreased as the size of hollow increased. Thus, the deflection of hollow beam decreased with the increase of size of opening. All the beams were undergo vertical cracking as there is no reinforcement.

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%	Percentage
σ	Flexural Strength
δ	Deflection

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
$Ca(OH)_2$	Portlandite
C_3S	Tricalcium silicate
C_2A	Dicalcium silicate
C_3A	Tricalcium aluminate
C_4AF	Tetracalcium aluminoferrite
C-H	Calcium Hydroxide
CIDB	Construction Industry Development Board
C-S-H	Calcium Silica Hydrate
FKASA	Faculty of Civil Engineering & Earth Resources
GHG	Greenhouse Gases
H_4SiO_4	Silicium acid
IBS	Industrialised Building System
LVDT	linear variable displacement transducer
PSBE	Processed Spent Bleaching Earth
SBE	Spent Bleaching Earth

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Concrete is a material used mostly in building construction. It is a composite material that consists of essentially of a binding medium such as mixture of Portland cement and water within which embedded particles of aggregates, usually a combination of fine and coarse aggregate. Global production of cement has grown and become one of the largest emission source of carbon dioxide.(Andrew, 2017) Cement production are requires a lots of mineral sources such as calcium, limestone and silicon. (Deng, Gao, & Qian, 2014) They are many disadvantages to the environmental which lead to many pollution and health problems. Refer to the Global carbon budget 2015, carbon dioxide (CO^2) emission was recorded as 5.6% distribute among coal, oil, gas and gas flaring. The CO^2 emission of cement production had increase slight around 0.5% to 6.1% compared to year 2015.(Andrew, 2017). Therefore, some cement industry had started to replace partially by other industrial waste in order to reduce the cost and make it more eco-friendly uses.

Spent Bleaching Earth (SBE) is a solid waste originating from edible oil refinery process which generates high quantities of waste due to refining process of crude edible oil. (Beshara & Cheeseman, 2014). Processed Spent Bleaching Earth (PSBE) is the SBE that has been treated and can be used as a partial replacement for cement in the foamed concrete due to its pozzolanic effect. Spent bleaching earth contain about 57% of silicon dioxide which were increase the strength of concrete. (Loh et al., 2013) The resulting calcium silicate hydrated into an extended network bonds which binds together the aggregates. This will increase the density of concrete and improve its strengths.

Foamed concrete was defined as a cementitious material that consists of minimum 20% of foam which is entrained into plastic mortar by mechanically. High rise building or skyscrapers had become trend in construction development and those buildings higher than 100 meters. (Access, 2017) For those building, the lightweight concrete are very useful in this construction sector. The lightweight concrete can reduce the dead load of building. Thus, lightweight concrete are important as they also can perform well structurally as normal weight concrete.("Structural lightweight concrete," 1981) The dry density of foamed concrete vary from 300 to 1600 kg/m^3. There are many advantages such as the use of lightweight concrete doesn't not cause freezing problem as well as thawing. The larger pores size in aggregate become more saturated and the air entrainment protected cement paste. The fire resistance of lightweight concrete also higher than the normal concrete. In addition, the lightweight concrete has lower thermal expansion and low tendency to break compared to normal concrete. High rise building is more advantaged to use the lightweight due to the reduction of weight of concrete can help easy transport and installation.

1.2 Problem Statement

The cumulative carbon dioxide emission were contributed by the cement production and fossil fuel combustion have increased by approximately 40%. (Allevi, Oggioni, Riccardi, & Rocco, 2017). Spent bleaching earth (SPE) is the bleaching of crude palm oil from physically refined palm oil and commonly direct landfill to the ground. (Beshara & Cheeseman, 2014) This type of disposal is expensive method and led to environmental degradation. (Loh et al., 2013) The disposal of oil were cause highly polluted waste water and solid waste containing waste vegetable oil (Park, Kato, & Ming, 2004). So, by using the Processed Spent Bleaching Earth (PSBE) can reduce the usage of cement and produce higher quality of concrete.

Weight of conventional concrete with high density are the main problem concerned by the structural designer. By imply the lightweight concrete, it can reduce the self-weight and total dead load to the foundation of the structures. In addition, the additional of hollow section along the beam can allow more mechanical works included wiring, electrical to pass through the beam. Besides this, the application of foamed concrete beam suitable for precast first floor and second floor beams.

1.3 Objectives

The goal of this research is to study the effect of circular hollow section on the strength of foamed concrete beam with processed spent bleaching earth (PSBE) as partial replacement of cement.

i. To determine the maximum load of the flexural beam by using 4 point bending test

ii. To determine the deflection of the beam

iii. To determine the mode of failure of the flexural beam.

1.4 Scope of Study

This study is focused on effect of circular hollow section on foamed concrete beam with processed spent bleaching earth as partial replacement of cement. Processed spent bleaching earth foamed concrete beam were designed with density 1600 kg/ m^3 with 30% PSBE as replacement of cement. In this study, they different size of circular hollow beam were prepared and tested based on ASTM C393 for four point bending test. The ultimate loading, deflection of beam and mode of failure were obtained from the four point bending test. The test were carried out after the foamed concrete undergo 28 days of water curing. This study was carried out at the Concrete Laboratory of Faculty of Civil Engineering & Earth Resources (FKASA) in Universiti Malaysia Pahang.

1.5 Significance of Study

This study can help to reuse the waste material like Processed Spent Bleaching Earth (PSBE) for the cement replacement materials. By commercialize the PSBE into construction sector also provide alternative material for future development. This can help to save the cost of disposal of PSBE for landfill and reduce the impacts of pollution towards environment. Beside this, the hollow section beam can also decrease the usage of cement in concrete. This not only save costs and also reduce the total load towards the foundation of structures.

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